ON THE DEVELOPMENT OF THE SKULL AND ITS NERVES IN THE GREEN TURTLE (CHELONE MIDAS), WITH REMARKS ON THE SEGMENTATION SEEN IN THE SKULL OF VARIOUS TYPES[1]

FOR these embryos the author is indebted to Sir Wyville Thomson and Mr. H. N. Moseley, the latter having sent him the smaller specimens, and the former the ripe and nearly ripe young. There are in all five stages.

1st Stage, ½-in. long.—The embryo is already fairly formed, for there are rudiments of all the principal organs. About fifty-two somatomes may be counted behind the head, and there are evidently seven clefts—four post-oral, two pre-oral, and one oral. The body of the embryo is tolerably distinct from the yolk-sac, the mesocephalic flexure is well marked, and the tail is coiled upon itself.

The regions of the body, viz., cervical, dorsal, and caudal, are plain. A fold lying between the fore and hind limbs shows the commencing carapace, which is at present the only mark to distinguish it from any other Sauropsidan embryo.

Half the ventral region is now taken up by the heart and its pericardium, and behind it the ventral laminæ have not closed below, thus showing the Wolffian bodies within. Posteriorly the umbilical vessels are seen emerging.

The limb-buds grow out from a continuous ridge, due to a thickening of the mesoblast at the upper part of the somatopleure.

The body-cavity extends into the head, thus corroborating Mr. Balfour's account of the same thing taking place in the Selachians.[2]

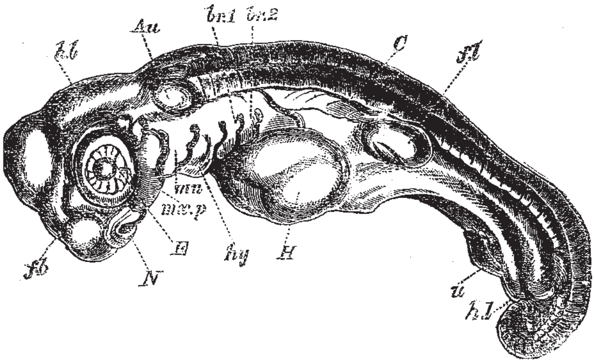

FIG. 1.—*Chelone midas*, 1st stage. *Au*, auditory capsule; *br.* 1 and 2, branchial arches; C, carapace; E, eye; *f.b*, fore-brain; *f.l*, fore-limb; H, heart; *h.b*, hind brain; *h.l*, hind limb; *hy*, hyoid; *m.b*, mid brain; *mn*, mandible; *mx.p*, maxillo-palatine; N, nostril; *u*, umbilicus.

As far as possible, the head has formed a coil similar to that of the tail, from which it never more than partially recovers. This bending of the head, which imprisons the elements of the face, sets the dorsal region free, and the neural canal expands to form the three vesicles of the brain. Buds are already seen on the forebrain which give rise to the hemispheres.

The axial tissues, below the nervous structures, are thickening into embryonic cartilage.

A sectional view shows the mid-brain to be bent like a horseshoe, forming the "middle trabecula" of Rathke, which is occupied by the apex of the notochord, its investing structures, and the third nerves.

Three pairs of chambers, for the organs of special sense, are built in the sides of the cranium.

The mouth is formed as in other types, by the extension of the third pair of clefts into one another; the fourth or mandibulo-hyoid cleft, being what is usually known as the first cleft.

The first post-oral visceral arch, forms most of the framework and machinery of the mouth, but as a rule, rudiments of pre-oral arches, supplemented by sub-cutaneous bones, finish the upper jaw.

On the whole, the series of clefts and folds along the face of the embryo are at this stage very regular, and the sense capsules are intimately connected with those which lie below them.

The slit-like opening of the nasal sac and the space between the eyeball and maxillo-palatine fold are very probably openings of the same nature as those behind them.

The tubular cartilage that forms round the external nostril is homologous with the "labial" that serves the same purpose in the Icthyopsida.

The floor of the skull is open under the fore-brain, and the double maxillo-palatine fold is sharply severed from the nasal fold. The fronto-nasal process is but little freed from the inferior cranial wall and the nasal folds.

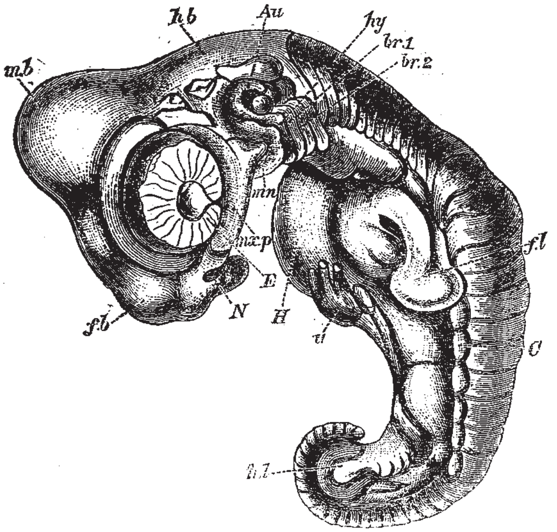

FIG. 2.—*Chelone midas*, 2nd stage. Letters as before.

2nd Stage, ⅝-in. long.—The proximal part of each limb now lies adherent to the infero-lateral region of the body in a manner very similar to what is seen in the osseous fishes. The edge above the deep sulcus between the marginal row of cutaneous folds and the ingrowing abdominal part of the body-wall is ultimately somewhat bevelled down, but it shows well that the structure in which the plastron is formed is not originally flat but trough-shaped.

The upper region of the mandible is already assuming the very image of the quadrate with its tympanic cavity and its condyles. In the cavity a discoid body—the "extra-stapedial" has developed. Between the second post-oral (hyoid) fold and the hollow of the quadrate elevation, the beginning of the membrana tympani is seen.

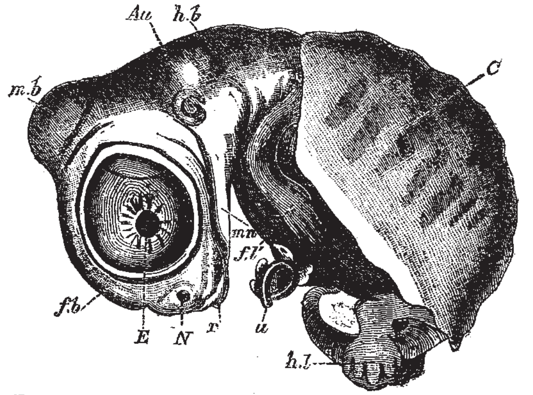

FIG. 3.—*Chelone midas*, 3rd stage. Letters as before. *r*, rostrum.

The eyeball is now at its relatively largest size, exceeding the mid-brain in bulk.

The maxillo-palatine fold is somewhat hour-glass shaped, and has a head-cavity in its fore part.

In the middle of the palate an open space appears into which the oral lining has grown. This diverticulum is the rudiment of the pituitary body. It lies where the hypoblast and epiblast

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[1] Abstract of a paper by Prof. Parker, F.R.S., read at the Royal Society on February 13.

[2] This extension of the body-cavity is also seen in the lizard.

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meet, but is probably formed from the latter. The infundibulum is beginning to grow towards the pituitary body, and close in front of it are seen the optic nerves which are still hollow. Rudimentary olfactory lobes are seen where the solid olfactory nerves are given off.

Cartilage is forming in the base and sides of the skull, as well as in the ear-capsules. The notochord ascends high into the head and is slightly curved over at the end. The azygous prochordal element, or inter-trabecular bar, is of equal size to the trabeculæ, which are now articulated with the hind part of the basis cranii, in front of the base of the ascending wall.

This stage is especially valuable in helping to a clear conception of the true nature of the prochordal part of the trabeculæ.

3rd Stage, 1¼-in. long.—In this stage the head has almost acquired the adult form, and the carapace is well marked out. The abdominal region is flattened to give rise to the plastron. The limbs have also practically acquired their adult form, and the heart is fairly inclosed in the thorax.

The post-oral clefts are now filled in, and the skull is thoroughly chondrified, forming a cartilaginous trough. The trabeculæ and inter-trabecula have grown into a high septum between the eyes and nose. From the former, the orbitosphenoids grow, and the alisphenoids extend from the orbitosphenoids to the auditory capsules. Ossification now begins in the palate.

The notochord turns round in the post-clinoid upgrowth of of the basal plate, and the sheath in its descending part becomes solid, and ends behind the lobules of the rudimentary pituitary body as a tear-shaped drop or lump of cartilage. If the head had been straight, this drop *might* have reached its fore end, directly below the first nerves. The inter-trabecula is a continuation of the same skeletal tract as the sheath of the notochord, and it reaches to the *actual* end of the head, while the drop of cartilage approaches the *organic* end.

4th Stage—two-thirds ripe—3-in. long.—In these embryos nearly all the adult structures can be seen. The epipterygoid is still, however, a cartilaginous hook hanging down from the quadrate. The columella is well developed, and its shaft is ossified.

The parietals have grown down the sides of the skull causing the alisphenoids to be absorbed to a great extent. The investing bones are now rapidly developed, but much of the endocranium is still soft.

5th Stage—ripe—4in. long.—The processes of development and ossification have now gone so far that little can be remarked upon as differing from the adult. The epipterygoid, however, which is wedged in between the descending parietal and the pterygoid, is now a distinct bone, but its apex permanently touches the apex of the pedicle of the quadrate, from which it was segmented.

The development of *Chelone midas* corresponds in all essentials with that of the common snake (*Tropidonotus natrix*) and lizard (*Lacerta agilis*) which the author has recently worked out; but it is well worth remarking that that which distinguishes the chelonian from other reptiles is already manifest in the first stage.

The author considers that there are several things in the head of the vertebrate embryo which are evidently of a segmental nature. Firstly, nerves in the head corresponding to spinal nerves. These constantly fork over clefts, which are also signs of segmentation. The number of inferior arches, whether pre-oral or post-oral, also indicate the number of segments that may exist in the head of a vertebrate. At any rate, wherever there is any diverticulum of a pleuro-peritoneal cavity, although divided off from that of the body by the clefts, there is that which corresponds to a somatome. By this last evidence there is at least one homologue of a pre-oral somatome, and if we go by the nerves, clefts, and cartilages, there are more.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Council of King's College have decided to give the name "Wheatstone Laboratory" to the physical laboratory of the College, in honour of Sir Charles Wheatstone, who was for some years Professor of Experimental Philosophy in the College, to which he also bequeathed his valuable collection of physical apparatus. The report of the laboratory work shows that the physical laboratory was established in the year 1868, and that during the eleven years of its existence about 250 students have been trained in it in the various branches of practical physics. The average number of occasional students—*i.e.*, students who are engaged in research and do not attend with any special class, has been nine a year during the last five years. Among these are graduates of the older universities, who come to reside in London after they have completed their term of residence at the University. Engineering students in their third year's course have the privilege of working in the laboratory free of charge. There are also special practical classes which have been well attended, for the Bachelor of Science and the Preliminary Scientific M.B. Examinations of the University of London, and also special classes for evening class students who are engaged in business during the day-time. In all there are not less than forty students now engaged in practical work in physics in "the Wheatstone Laboratory" in King's College. The Laboratory is greatly in need of endowment, in order that an additional Demonstrator may be appointed, and the usefulness of the laboratory still further extended.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, March.—We note the following papers in this number:—Concerning $\frac{T_1-T_0}{T_1}$, or the limit of efficacy of steam-engines, by Mr. Klein.—Gauging- and measuring-implements, by Mr. Richards.—A new engine-governor, by Prof. d'Auria.—Conical arches at South Street Bridge, Philadelphia, Pa., by Mr. Stauffer.—Graphic freight diagrams, by Mr. Dudley.

Bulletin de l'Académie Royale de Belgique, No. 1, 1879.—This contains an interesting paper by M. Niesten, on the colours of double stars, which he was led to study by the variations in intensity and colour of planets in relation to the sun. He finds that in systems which allow of connecting the colours with position of the satellite in its orbit, the principal star is white or pale yellow when the companion is at periaster, whereas in other positions it is yellow, gold yellow, or orange. The companion follows the principal star in its fluctuations of colour, and often exceeds it as it removes from periaster (where it is mostly white, like the principal). In perspective groups, the companion is nearly always blue, by an effect (the author suggests) similar to that by which mountains on the distant horizon look blue (and pointing to a gaseous medium in celestial space).—M. Delarge describes some instructive experiments on the telephone, applied in the neighbourhood of ordinary telegraph lines. Secrecy can be insured for telegrams, with dial-apparatus or that of Hughes, but the former is objectionable as leaving no trace, and the latter is very expensive and delicate. Hence recourse should generally be had to cipher.—M. Marchal contributes a revision of American Hederaceæ, describing eighteen new species and a genus.—M. Chevron is led to deny the inalterability of tricalcic phosphate by citrate of ammonia; but the use of this solvent for separation of the phosphate may give sufficiently exact results if a too great excess of the citrate solution be avoided.—We further note an analysis of, and reports on, the second part of M. Lagrange's work on the origin and establishment of astronomical movements, wherein is assumed that the material atoms were originally diffused through space in a state of rest and at the absolute zero of temperature, and endowed simply with reciprocal attraction.—M. Malaise writes on arsenopyrite, or mispickel, and on the arsenical water of Court Saint-Etienne.

No. 2. We have here a paper by M. Saltel on a mathematical paradox, and on a new character of decomposition due to the presence of multiple lines.—M. van Beneden records the receipt of some interesting fossils of cetacea from marls of the tertiary epoch in Croatia.

THE *Revue Internationale des Sciences* (January-March, 1879), contains the following papers of interest: On the cell soul and soul cells, by Ernst Haeckel.—On the nutrition of plants, by J. L. de Lanessan.—Analysis of two memoirs on *Noctiluca*, by G. Carlet.—On a monstrous skeleton of a batrachian, by F. Lataste.—Researches on *Bacteria*, by Dr. Koch.—On vascular innervation, by MM. Grutzner and Heidenhain.—On the action of light and heat upon moving spores, by E. Strassburger and E. Stahl.—On contagious diseases and disinfecting agents, by Prof. Naegeli.—General observations on fertilisation, by E. Strassburger.—On a technical process for the study of fish embryos, by F. Henneguy.—On the retina red and its relation to vision, by

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